(12) UK Patent Application (19) GB (11) 2 355 747 (13) A

(43) Date of A Publication 02.05.2001

(21) Application No 0026687.4

(22) Date of Filing 01.11.2000

(30) Priority Data
(31) 09430916 (32) 01.11.1999 (33) US

(71) Applicant(s)
Baker Hughes Incorporated
(Incorporated in USA - Delaware)
Suite 1200, 3900 Essex Lane, Houston, Texas 77027,
United States of America

(72) Inventor(s)
Mohammad Swadi
Terry Koltermann
Kenneth C Brannon

(74) Agent and/or Address for Service
Frank B Dehn & Co
179 Queen Victoria Street, LONDON, EC4V 4EL,
United Kingdom

(51) INT CL[7]
E21B 10/22

(52) UK CL (Edition S)
E1F FFE FFF

(56) Documents Cited
GB 2326894 A SU 001767150 A US 5593231 A
US 5265964 A

(58) Field of Search
UK CL (Edition R) E1F FFE FFF FGD
INT CL[7] E21B 10/18 10/22 10/24
Online: EPODOC, JAPIO, WPI

(54) Abstract Title
Journal bearing for earth-boring bit

(57) An earth-boring bit having a bit body 12 and bearing shaft 19 comprises a cylindrical journal bearing surface 21 and a cutter 36 locked to the bearing shaft by balls 35 in a bearing channel. A transverse hole 46 is located on the non-loaded side of an axis of the bearing shaft. The hole intersects with a ball plug hole 37 and with the journal bearing surface at a trailing side and a leading side and communicates with both leading and trailing side ports (47 and 49, figure 4). Journal flats on the bearing shaft communicate with the trailing side port and the leading side port. The leading side journal flat is a different size than the trailing side journal flat to enhance circulation of a lubricant from a source 17 via passages 41, 37, and 46, to the journal bearing surface.

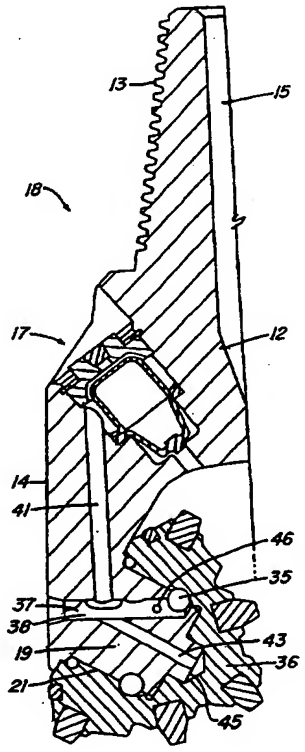

Fig. 2

GB 2 355 747 A

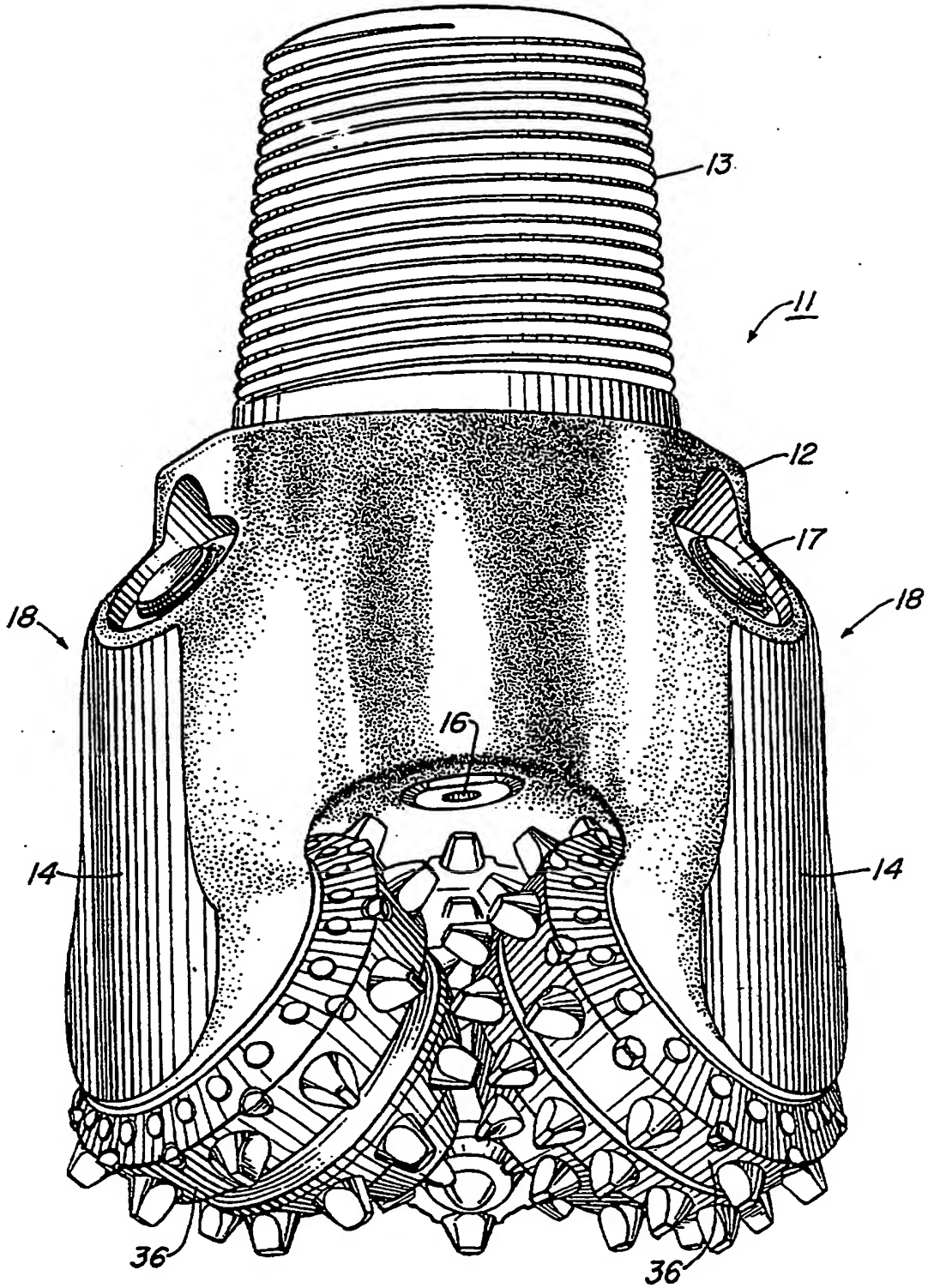

Fig. 1

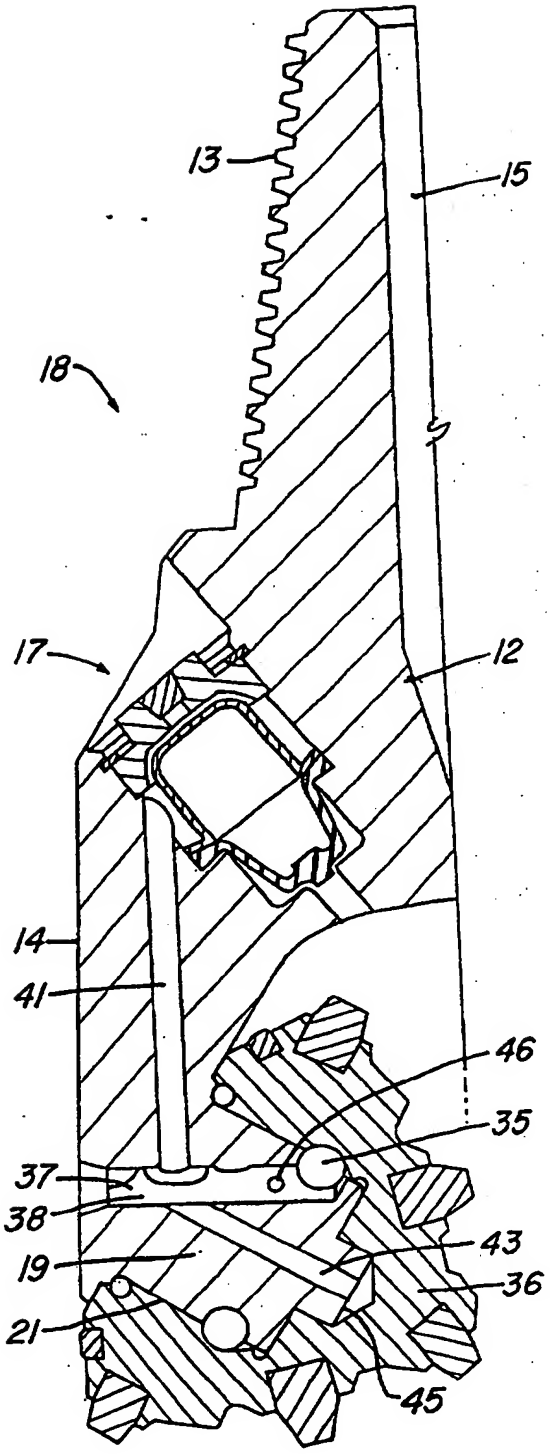

Fig. 2

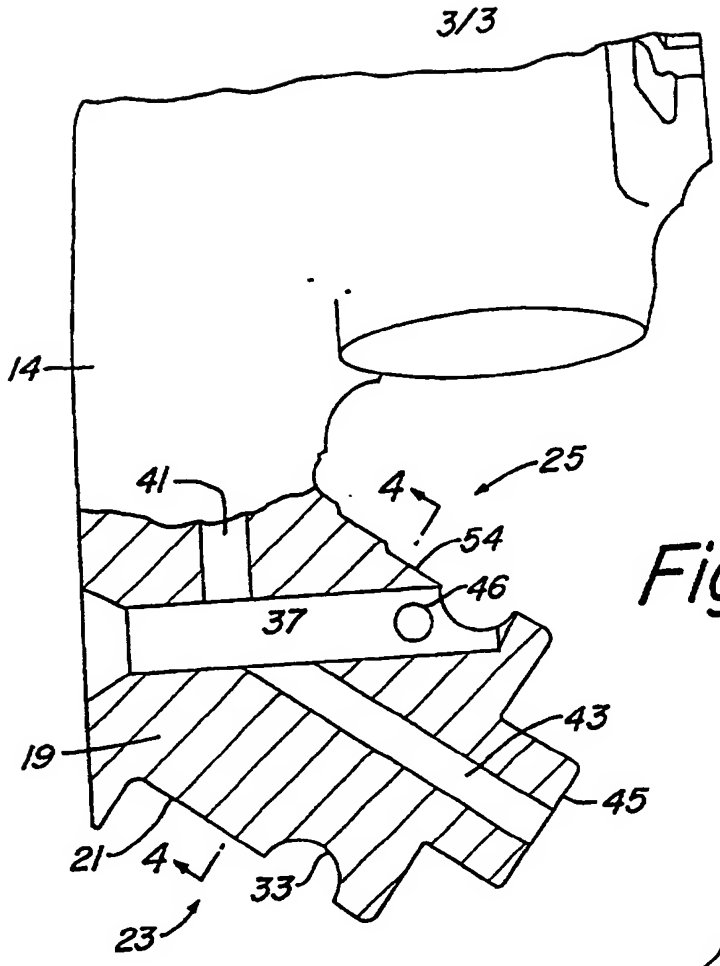

Fig. 3

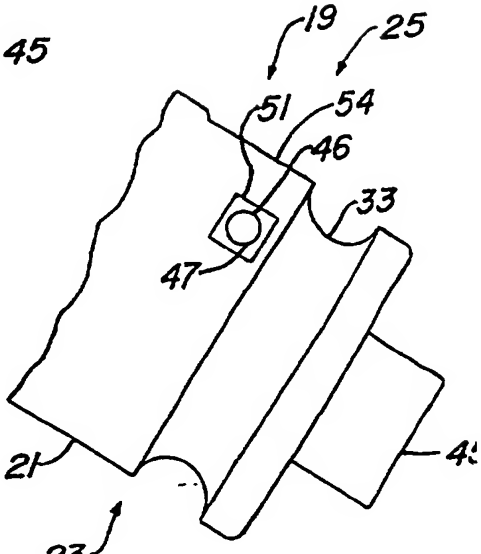

Fig. 5

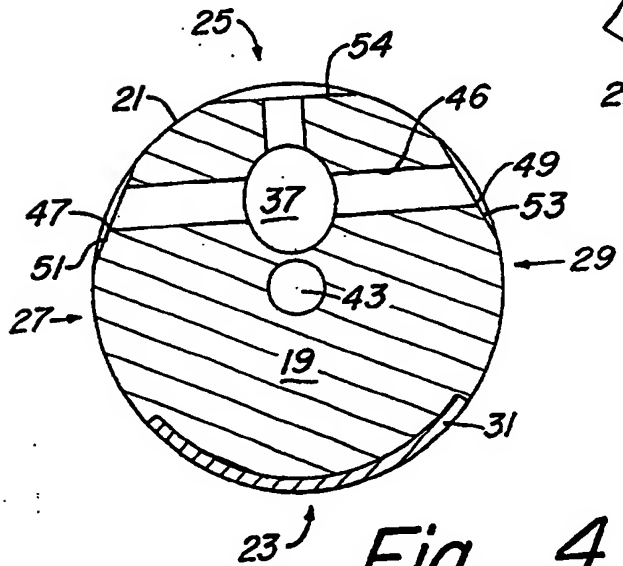

Fig. 4

JOURNAL BEARING FOR EARTH-BORING BIT

This invention relates in general to earth-boring bits, particularly to an earth-boring bit having at least one rotatable cutter mounted on a bearing shaft that has multiple lubricant ports designed to increase circulation of lubricant to the bearing in the bearing shaft.

The success of rotary drilling enabled the discovery of deep oil and gas reservoirs. The rotary rock bit was an important invention that made the drilling possible.

Only soft earthen formations could be penetrated commercially with the earlier drag bit, but the two cone rock bit, invented by Howard R. Hughes, U.S. Patent 930,759, drilled the cap rock at the Spindletop Field near Beaumont, Texas with relative ease. That venerable invention, within the first decade of this century, could drill a scant fraction of the depth and speed of the modern rotary rock bit. If the original Hughes bit drilled for hours, the modern bit drills for days. Modern bits sometimes drill for thousands of feet, instead of merely a few feet. Many advances have contributed to the impressive improvements in rotary rock bits.

In drilling bore holes in earthen formations by the rotary method, rotary rock bits having one, two or three rolling cutters rotatably mounted thereon are employed. The bit is secured to the lower end of a drill string that is rotated from the surface or by downhole motors or turbines. The cutters mounted on the bit roll and slide upon the bottom of the borehole as the drill string is rotated, thereby engaging and disintegrating

the formation material to be removed. The roller cutters are provided with teeth that are forced to penetrate and gouge the bottom of the borehole by weight from the drill string.

Normally, the rolling cutters are rotatably mounted onto a journal bearing. Each cutter is locked on the bearing shaft by a plurality of balls housed in a channel in the bearing shaft. To prolong the life of the bearings, a lubrication reservoir is provided in each bit leg to deliver lubricant to the bearings. Passages extend from the reservoir through the shaft to the bearing areas. Flats are provided in the journal surface of some prior art bits to trap lubrication.

According to a first aspect of the present invention there is provided an earth-boring bit as claimed in claims 1 and 7.

According to a second aspect of the present invention there is provided a method as claimed in claim 9.

This preferred embodiment consists of lubricant ports and recesses in the bearing surface which are designed to increase the circulation of lubricant between the bearing and the lubricant reservoir. The preferred embodiment consists of two lubricant ports centered in recesses on a non-loaded side of a head main journal bearing and a single lubricant port in the top of the head bearing pilot pin. All three ports reside at the end of holes which intersect a ball plug hole that, in turn, intersects a hole connecting the lubricant reservoir with the bearing. The two ports in the non-loaded side of the head main journal bearing are approximately 115° on either side of a line defining the center of pressure of a side hardfacing inlay. In the preferred embodiment these two ports are at the ends of a single hole in the bearing that intersects the ball plug hole. The two

recesses in which these two lubricant ports reside differ in size. The recess on the trailing side with respect to cone rotation is larger than the recess on the leading side of the bearing shaft. The differing size of the recess on the trailing side and the leading side of the bearing shaft facilitates lubricant circulation as a cutter rotates about the bearing shaft.

Various embodiments of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a perspective view of an earth-boring bit according to the preferred embodiment;

Figure 2 is a cross-sectional elevation view of a one-third section of the earth-boring bit of Figure 1.

Figure 3 is an enlarged cross-sectional view of the bearing shaft of the earth-boring bit of Figures 1 and 2.

Figure 4 is a cross-sectional view of the bearing shaft taken along line 4-4 of Figure 3.

Figure 5 is an elevational view of the bearing shaft of the earth-boring bit of Figures 1, 2 and 3.

Referring now to Figures 1 and 2, numeral 11 designates an earth-boring bit having a threaded upper portion 13 for connection to a drill string member (not shown). A fluid passage 15 directs drilling fluid to a nozzle 16 that impinges drilling fluid against a bore hole bottom to flush cuttings to the surface of the earth. The earth-boring bit 11 has a plurality of legs 14 that extend downwardly from the bit body 12.

A lubricant source or pressure compensating system 17 (Figures 1 and 2) is contained within each section 18 of the body. Typically, there are three sections 18, which are welded to form the bit body 12. The lubrication system is preferably similar to that shown in U.S. Patent 4,727,942.

Referring now to Figures 2 - 5, a bearing shaft 19 depends downwardly and inwardly from a section 18 of bit body 12. Bearing shaft 19 has a generally cylindrical journal bearing surface 21. As shown in Figure 4, bearing shaft 19 has a loaded side 23, a non-loaded side 25, a trailing side 27 and a leading side 29 with respect to the rotation of earth-boring bit 11. A hardfacing inlay 31 may be located on loaded side 23 of bearing shaft 19.

Referring to Figure 3, an annular channel 33 on journal bearing surface 21 surrounds bearing shaft 19 to receive balls 35 (Figure 2). Balls 35 lock cutter 36 to bearing shaft 19. A ball plug hole 37 communicates between the journal bearing surface 21 and the bearing channel 33 for inserting balls 35 into channel 33. After insertion, a plug 38 is installed in ball plug hole 37 to retain balls 35 in channel 33.

The pressure compensating system 17 (Fig. 2) is located in bit body 12 proximate threaded upper portion 13. A lubrication passage 41 communicates the pressure compensating system 17 with the ball plug hole 37 for delivering lubricant from pressure compensating system 17 to the ball channel 33 and journal bearing surface 21. A pilot pin hole 43 (Fig. 3) communicates a nose 45 of bearing shaft 19 with ball plug hole 37. Pilot pin hole 43 is preferably located on the axis of bearing shaft 19.

A transverse hole 46 (Fig. 4), preferably intersects at a right angle with ball plug hole 37 and communicates with journal bearing surface 21 at a trailing side port 47 and a leading side port 49. Transverse hole 46 is preferably located on the non-loaded side 25 of an axis of bearing shaft 19. In the preferred embodiment, trailing side port 47 exits bearing shaft 19 at 115° from a line defining the center of pressure of hardfacing inlay 31, which is located on loaded side 23 of bearing shaft 19. The circumferential distance between ports 47 and 49 is about 130 degrees. A trailing side journal flat 51 is located on trailing side 27 of bearing shaft 19 at trailing side port 47. In the embodiment shown, flat 51 is a generally planar surface that is normal to a radial line of the axis of bearing shaft 19. However, flat 51 need not be located in a plane because its purpose is to provide a cavity for trapping lubricant. Flat 51 has a maximum depth at port 47 and a length and width selected to provide a cavity of selected volume.

The leading side port 49 exits bearing shaft 19 at 115° from the line defining the center of pressure on hardfacing inlay 31 on the leading side 29 of the bearing shaft 19. A leading side journal flat 53 is provided on leading side 29 of bearing shaft 19 at the leading side port 49. The leading side journal flat 53 is similar in configuration to trailing side flat 51, but is preferably smaller in volume than the trailing side journal flat 51. The difference in volume of the cavities of flats 51, 53 enhances lubricant circulation when cutter 36 is rotated about bearing shaft 19. A middle journal flat 54 is provided on the non-loaded side 25 of bearing shaft 19 centered between flats 51, 53. The middle journal cavity or flat 54 is larger than either the trailing side journal flat 51 or the leading side journal flat 53.

In operation, a bit body 12 is inserted in a wellbore. The bit body 12 is rotated by a drilling string that exerts downward pressure on the wellbore due to pressure caused by the weight of the drill string. Cutter 36 engages the bottom of the wellbore in sliding and rotating engagement. Lubricant is provided from pressure compensating system 17. Lubricant is delivered down lubricating passage 41 and into ball plug hole 37. Lubricant is delivered to the ball channel 33 and to the journal bearing surface 21. As the cutter 36 rotates about the bearing shaft 19, the size difference between the leading side journal flat 53 and the trailing side journal flat 51 results in an enhanced circulation of lubricant through transverse hole 46. The lubricant flows into the area surrounding the journal bearing surface 21 and into the annular space between the bearing shaft 19 and the cutter 36. Additionally, lubricant is able to flow through pilot pinhole 43 out of the tip 45 of the bearing shaft 19 and into a space between the bearing shaft 19 and the cutter 36.

The invention has numerous advantages. The advantages include increased lubricant flow from a pressure compensating system to the bearings of a roller cutter bit. By positioning flats of different volume on the generally cylindrical journal bearing surface, an increased lubricant flow is facilitated simply and inexpensively.

While the invention has been shown in only one of its forms, it should be apparent to those skilled in the art that it is not so limited, but is susceptible to various changes without departing from the scope of the invention.

Claims

1. An earth-boring bit comprising:

a bit body;

at least one bearing shaft depending inwardly and downwardly from said bit body, said bearing shaft having an axis and a journal bearing surface;

a lubricant reservoir in said bit body;

lubrication passages communicating said lubricant reservoir with said journal bearing surface;

a first cavity formed on said journal bearing surface in communication with said lubricant passages;

a second cavity formed on said journal bearing surface in communication with said lubricant passages, wherein said second cavity has a different volume than said first cavity to facilitate circulation of lubricant to said journal bearing surface; and

at least one cutter mounted for rotation on the bearing shaft.

2. The earth-boring bit according to claim 1, wherein said cavities comprise flats formed in said bearing surface.

3. The earth-boring bit according to claim 1 or 2, wherein:

said first cavity is on a trailing side of said bearing shaft; and

said second cavity is on a leading side of said bearing shaft.

4. The earth-boring bit according to claim 3, wherein:

said second cavity is smaller in volume than said first cavity.

5. The earth-boring bit according to any preceding claim, further comprising:

a middle cavity on said journal bearing surface between said first and second cavities.

6. The earth-boring bit according to any preceding claim, wherein said lubrication passages include a transverse passage substantially perpendicular to said axis of said bearing shaft, terminating in a leading port on a leading side of said bearing shaft and a trailing port on a trailing side of said bearing shaft and wherein said cavities are located at the leading and trailing ports.

7. An earth-boring bit comprising:

a bit body;

at least one bearing shaft depending inwardly and downwardly from said bit body, said bearing shaft having an axis and a journal bearing surface;

a channel surrounding said bearing shaft for receiving balls;

a ball plug hole communicating an exterior side of said bit body with said channel to insert balls into the channel;

a lubrication reservoir in said bit body;

a lubrication passage extending from said reservoir to said ball plug hole;

a transverse hole in said bearing shaft substantially perpendicular to said axis and intersecting said ball plug hole, said transverse hole having a first port on a trailing side of said journal bearing surface and at a second port on a leading side of said journal bearing surface;

a first journal flat on said bearing surface surrounding said first port;

a second journal flat on said bearing surface surrounding said second port, wherein said second journal flat is larger in volume than said first journal flat to facilitate circulation of lubricant to said journal bearing surface when a cutter is rotatably installed thereon.

8. The bearing shaft according to claim 7, further comprising:

a middle journal flat on said bearing surface between said first and second journal flats.

9. A method of increasing lubrication circulation in an earth-boring bit that has a bit body, at least one bearing shaft having a journal bearing surface, a lubrication reservoir and a cutter rotatably mounted in the bearing shaft, the method comprising the steps of:

providing first and second journal cavities on said journal bearing surface circumferentially spaced apart from one another, differing in size from one another and flowing lubricant from said reservoir to said journal bearing surface.

10. The method according to claim 9, wherein

said second journal cavity is smaller that said first journal cavity.

11. The method according to claim 9 or 10, wherein:

said second journal cavity is located on a leading side of said bearing shaft.

12. An earth-boring bit substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB 0026687.4
Claims searched: 1-12

Examiner: Ian Blackmore
Date of search: 28 November 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): E1F FFE, FFF, FGD

Int Cl (Ed.7): E21B

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2326894 A	(SMITH INTERNATIONAL INC) see figure 14	-
A	US 5593231 A	(DRESSER IND) see figure 3	-
A	US 5265964 A	(SMITH INTERNATIONAL) see figure 5	-
A	SU 1767150 A	(SVARKANEFTEGAZSTROI) see whole document	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

BNSDOCID: <GB_____2355747A_I_>